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SEAL ASSEMBLY

This invention relates to a novel seal assembly.

Natural gas is commonly transported, in bulk, across land through large diameter (eg 24 inch) steel pipelines. It is not uncommon to introduce offtakes or three way joints at certain points on the main transmission pipeline. Currently, a three way joint is welded into the pipeline, following the removal of a section of pipe. This procedure when carried out with gas loaded into the line is hazardous and expensive, involving the installation of a secondary "loop" through which to bypass the gas whilst the joint is installed.

We have now found a novel form of seal which is capable of acting as a primary sealing element that can provide a seal between a main transmission line and bonded branch connection. The seal must withstand service and test pressure including pressure reversals and must also be able to accommodate eccentricity of the branch connection to the main pipeline.

Copending British Patent Application No. 9917 360.1 describes a novel method of securing a branch assembly to a pipeline. Such a method requires a specialised seal which is not only adapted to operate under significant pressures but can also be fitted to non-planar or arcuate surfaces.

British Patent Application No. 1214986 describes a sealing means for use with a pair of pipes which are angularly movable relative to each other. Generally, the sealing means comprises an annular body portion and a pair of spaced tongues, the tongues being provided with inwardly inclined ears. However, the seal described therein is designed for use in connection with "parallel" pipeline flange joints. The seal does not provide a solution to the problem of forming a fluid tight seal in a branched pipeline.

Thus it is known to use "U" ring seals in pressure systems wherein the pressure acts on the side wall of the U ring. However, we have now surprisingly found a novel seal assembly which is sufficiently flexible so as to be adaptable to fit parallel, planar, arcuate or convex surfaces.

Thus according to the invention we provide a seal assembly adapted for use in a pressurised system which comprises a ring seal provided with at least a pair of primary sealing lips radially disposed on a first, circumferential, face of the ring, the second, radial face of the ring seal being provided with means for dispersing pressurised fluid.

In a preferred embodiment of the invention the means for dispersing pressurised fluid comprises means for dispensing pressure in a circumferential and a radial direction.

The seal of the invention is advantageous in that it is especially useful in pressure systems since the pressure acts on the walls of the lips and the portion of the seal joining the lips to enhance the pressurised fluid seal produced. The seal will hereinafter be described as a radial U ring seal.

In conventional land based pipelines the pressure differential is such that the internal face of the seal experiences greater pressure than the external face. Thus, in such an embodiment, the first circumferential face of the seal is the inner face and the second circumferential face is the outer face.

In a further embodiment of the invention the seal arrangement may be such that the external pressure on the seal is greater than the internal pressure. Such seals are, for example, advantageous in that they may be suitable for sub-sea pipelines.

In an alternative embodiment of the invention for use in sub-sea applications, it may be necessary to provide means of sealing to prevent the ingress of water which may be (at times) at a higher pressure than the pipeline fluid. In this case a pair of primary

sealing lips may be radially disposed from an outer circumferential face of the ring, whilst means for dispersing pressurised fluid is provided on the inner radial face of the ring.

The dispersing means may comprise a labyrinth seal, which may be located on the radial face of the seal. In a preferred embodiment both radial faces of the radial U ring seal are provided with a pressurised fluid dispersing member, in which case the labyrinth seals may be the same or different.

Labyrinth seals are known to cause reductions in pressure across the radial width of the seal. Thus, the labyrinth seals used may comprise an array of apertures. Alternatively, the labyrinth seals may only be partially cut through such that the seal comprises a plurality of hollows or holes. The apertures or holes (together referred to as "the bulkheads") may be arranged irregularly or preferably, in a regular pattern. When a regular pattern is used a 'brick-bond' pattern is preferred, that is, the bulkheads are offset in relation to one another. On opposite sides of the seal faces the bulkheads may be circumferentially offset to one another, for example, by half the pitch of the bulkhead. Alternatively, the bulkheads may not necessarily be offset. Although it is within the scope of the present invention for the labyrinth seals to be separate to the radial U ring seal, or to be bonded to the radial U ring seal, it is preferred that the labyrinth seal is an integral part of the radial U ring seal. When the apertures or holes are in a regular pattern they may comprise two or three circumferential rows. Two circumferential rows are preferred.

The thickness of the labyrinth seal may vary, but is preferably from 1 to 5mm, more preferably from 1.0 to 2.5 mm. The dimensions of the apertures or holes may also be varied depending upon, *inter alia*, the pressure which the seal is subjected to, the material of which the seal comprises, etc. However, it is preferred that the apertures or holes have a depth of from 0.5 to 2.0 mm and more preferably from 1.0 to 1.5 mm. For ease of manufacturing the apertures or holes are preferably substantially the same size and shape and may be substantially rectangular with dimensions of from 5 to

10 mm radial width by 15 to 20 mm circumferential length, preferably 8 by 16 mm. When rectangular apertures/holes are used then the longest side is preferably circumferential.

Any conventionally known materials may be used in the manufacture of the seals of the invention and preferably the labyrinth seal portion comprises the same material as the U ring portion of the seal. Such materials include elastomers and/or plastics. Examples of elastomers include, but are not limited to rubbers, e.g. natural or synthetic rubbers. Of these synthetic rubbers are preferred such as nitrile rubbers, eg acrylonitrile butadiene copolymer (NBR), hydrogenated acrylonitrile butadiene rubber (HNBR), fluoroelastomers (FKM), such as Viton or perfluoroelastomers (FFKM), such as Kalrez. (Viton® and Kalrez® are available from Du Pont Dow Elastomers). Examples of plastics materials include fluorinated polymers such as PTFE (polytetrafluoroethylene).

The hardness of the elastomer, e.g. HNBR, may be varied. However, it is preferred that the hardness lies in the range of from 50 to 95 degrees Shore A.

The pressure which the seals of the invention are designed to tolerate may be up 105 to 110 bar under test conditions and from 20 to 70 bar under conventional operating conditions. Moreover the seals of the invention may withstand external pressures of up to 350 bar, e.g. from 20 to 350, preferably from 70 to 300, more preferably from 105 to 180 bar.

Under operating conditions there may be a risk of circumferential extrusion between the outer portion of the seal and the pipes. Thus, in a preferred embodiment a reinforcement member around the outer circumference of the seal eg a coiled spring. The spring is preferentially a metal spring eg a steel spring.

Furthermore, since the seal assembly is free to continually expand in a radial direction under the working pressure acting on the lips of the seal. Thus, in a

preferred embodiment of the invention the seal may be provided with a containment member. Such a containment member preferentially comprises a metal ring situated on the non-pressure facing surface of the seal. The containment member may optionally be integral to the seal ring or may be separate.

Thus in land based pipelines the containment member is preferentially on the outer surface of the seal ring. However, for use in connection with sub-sea pipelines, the containment member is preferentially on the inner surface of the seal ring .

In systems where the pressure differential across the seal may be variable and/or in sub-sea applications a plurality of seal rings of the invention may be used. For example, an outermost seal may comprise a seal with outer facing sealing lips and an innermost seal may comprise a seal with inner facing sealing lips. In such a system the innermost and outermost seals may be separate, but may or may not be positioned adjacent to each other.

However, in a yet further embodiment of the invention a seal is provided wherein the seal comprises an innermost seal and an outermost seal which share a common containment member.

Thus according to a further feature of the invention we provide a seal assembly adapted for use in a prescribed system which comprises a pair of primary sealing lips radially disposed on an inner circumferential face of the seal ring, the primary and secondary lips being connected by a containment member.

In a preferred embodiment of the invention the seal is provided with means for dispersing pressurised fluid as hereinbefore described. Further the seal assembly as hereinbefore may comprise a single common containment member

The common containment member may optionally be integral to the ring seals or may be separate.

The seal assembly of the invention finds utility particularly as large pipeline seals such as may be required in the oil, chemical, water or gas fields. They are capable of sealing surfaces which are parallel; non-parallel, eg by up to 5mm; or , arcuately eccentric, as may be found when a portion of the side wall of a pipe may be cut away. The seals are especially useful in introducing, for example, a three way joint, into a pipeline by connecting two pipes.

Thus the seal assembly may be suitable for use in land based pipelines or sub-sea pipelines.

According to a further feature of the invention we provide a method of introducing a three way joint into a pipeline which comprises a hole in a pipe and attaching a second pipe over the hole wherein the seal of the invention lies between the two pipes.

We further provide a method as hereinbefore described which is suitable for use in a variable pressure system, such as a sub-sea system. Such a method may comprise using a plurality of seals of the invention. The method especially comprises using an outermost seal which may be provided with outer facing sealing lips and an innermost seal which may be provided with inner facing sealing lips. In such a system the innermost and outermost seals may be separate, but may or may not be positioned adjacent to each other.

The invention will now be described by way of example only and with reference to the accompanying drawings in which;

Figure 1 is a perspective view of a segment of a conventionally used U ring;

Figure 2 is a perspective view of a segment of a radial U ring seal of the invention;

Figure 3 is a cross-section of a segment of a radial U ring seal provided with a labyrinth seal;

Figure 4 is a cross-section of the complete seal of the invention;

Figure 5 is a plan view of the complete seal of the invention;

Figure 6 is a cross-section of the seal of the invention for use in sub-sea pipelines; and

Figure 7 is a cross-section of a branched sub-sea pipeline using the seals of the invention; and

Figure 8 is a cross-section of a dual seal assembly.

Referring to Figure 1 a conventional U ring seal (which is not of the invention) a seal (1) comprises lips (2 and 3) and lip joining section (4) and a body (5). The body (5) has outer walls (6 and 7). The seal (1) which is shown in segment only, is substantially circular such that the wall (6) is on the inside of the circle and the wall (7) on the outside of the circle.

With reference to Figure 2, a radial U ring lip seal (8) comprises lips (9 and 10), a lip joining section (11) and a body (12). The body (12) has outer faces (13 and 14). The seal (8) is substantially circular such the lips (9 and 10) face inwards towards the centre.

With reference to Figures 3 to 5, a lip seal (8) comprises lips (9 and 10), the body (12) of the seal being provided with labyrinth seals (15 and 16) on each face (13 and 14) respectively. The labyrinth seals (15 and 16) are in a "brickwork" arrangement. The body (12) of the seal (8) is provided with a support ring (17) in the form of a coiled spring moulded into the seal body (12). The seal (8) is also provided with a containment ring (18) on the face outermost from the centre.

With reference to Figure 6, a sub-sea lip seal (10) comprises lips (20 and 21), the body of the seal being provided with labyrinth seals (not shown) as hereinbefore described. The lips (20 and 21) are positioned on the outer facing surface (22) of the seal (19). The body is provided with a support ring (23) and optionally with a containment member (not shown).

With reference to Figure 7, a sub-sea pipeline (24) comprises a main pipe body (25) and a branched pipe (26). The main pipe (25) is provided with an aperture (27) which is coincident with the branched pipe (26). The branched pipe (26) is provided with a flange (28) which overlies the main pipe (25). The gap (29) between the flange (28) and the main pipe body (25) is plugged with seal (30) and seal (31a). Seal (30) is provided with inward facing lips (32) which acts to prevent leakage from inside the pipeline (24). Seal (31) is provided with outward facing lips (33) which acts to prevent leakage into the pipeline (24) if the external pressure is greater than the internal pressure.

With reference to Figure 8, a radial U ring (34) is adapted for use in a variable pressure system. The seal (34) comprises a pair of inner facing lips (35 and 36) attached to a first body portion (37). The body (37) is provided with a support ring (38) and a containment ring (39) and the containment ring (39) is adjacent the support ring (39). The containment ring (39) may be integral to the support ring (38), or may be, for example, fixed onto the support rings (38), or may simply be sandwiched into position.

The containment ring (39) has a first face (40) which abuts or is connected to the support ring (38) and a second opposite face (41). The second face (41) is situated adjacent to a second support ring (42), the support ring (42) being attached to a second body (43) which is provided with lips (44 and 45).

Each of the bodies (37 and 43) is provided with labyrinth seals (46, 47, 48, 49) on the respective radial faces (50, 51, 52, 53).

P36131WO.4

CLAIMS

1. A seal assembly adapted for use in a pressurised system which comprises a seal ring provided with at least a pair of primary sealing lips radially disposed on a first, circumferential, face of the ring, a second, radial, face of the ring seal being provided with means for dispersing pressurised fluid.

2. A seal assembly according to claim 1 characterised in that the means for dispersing the pressurised fluid comprises means for dispersing pressure in a circumferential direction.

3. A seal assembly according to claim 2 characterised in that the means for dispersing the pressurised fluid comprises means for dispersing pressure in a circumferential direction and a radial direction.

4. A seal assembly according to claim 1 characterised in that the means for dispersing the pressurised fluid is a labyrinth seal located on the radial side face.

5. A seal assembly according to claim 1 characterised in that the first circumferential face of the seal is the inner face and the second circumferential face is the outer face.

6. A seal assembly according to claim 1 characterised in that the seal is adapted to be used in a system wherein the external pressure on the seal is greater than the internal pressure.

7. A seal assembly according to claim 6 characterised in that the primary sealing lips are radially disposed from an outer circumferential face of the ring, whilst means for dispersing pressurised fluid is provided on the inner radial face of the ring.

8. A seal assembly according to claim 1 characterised in that both outer side faces of the radial U ring seal are provided with a pressurised fluid dispersing means.

9. A seal assembly according to claim 7 characterised in that the labyrinth seal comprises a plurality of apertures.

10. A seal assembly according to claim 7 characterised in that the labyrinth seal comprises a plurality of holes.

11. A seal assembly according to claims 9 or 10 characterised in that the apertures or holes are arranged in a regular pattern.

12. A seal assembly according to claim 11 characterised in that the regular pattern is a 'brick-bond' pattern.

13. A seal assembly according to claim 1 characterised in that the means for dispersing the pressurised fluid an integral part of the radial face of the seal ring.

14. A seal assembly according to claim 12 characterised in that the apertures or holes are in a regular pattern of two or three circumferential rows.

15. A seal assembly according to claim 14 characterised in that the apertures or holes are in a regular pattern of two circumferential rows.

16. A seal assembly according to claims 9 or 10 characterised in that the apertures or holes are from 0.5 to 2.0mm deep.

17. A seal assembly according to claims 9 or 10 characterised in that the apertures or holes are preferably substantially the same size and shape.

18. A seal assembly according to claim 1 characterised in that the assembly is adapted to tolerate from 20 to 70 bar under conventional operating conditions.

19 A seal assembly according to claim 1 characterised in that the seal is provided with a containment member.

20. seal assembly according to claim 1 characterised in that the containment member is on the outer surface of the ring seal.

21 A seal assembly according to claim 1 characterised in that the containment member is on the inner surface of the ring seal.

22. seal assembly according to claim 21 characterised in that the containment member comprises a reinforcement member around the outer circumference of the seal.

23. A seal assembly according to claim 1 characterised in that the reinforcement member is preferentially a coiled spring.

24. A seal assembly according to claim 1 characterised in that the seal is provided with a containment ring around the outer circumference of the seal.

25. A seal assembly which comprises a pair of primary sealing lips radially disposed on an inner circumferential face of the ring seal, the primary and secondary lips being connected by a containment member.

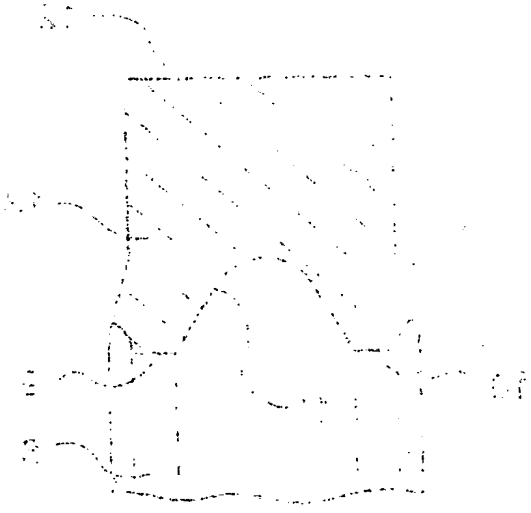
26. A method of introducing a three way joint into a pipeline which comprises a hole in a pipe and attaching a second pipe over the hole wherein the seal of the invention lies between the two pipes.

27. A method according to claim 26 characterised in that the method comprises using a plurality of seals according to claim 1.

28. A method according to claim 27 characterised in that the method comprises using an outermost seal which is provided outer facing sealing lips and an innermost seal which is provided with inner facing sealing lips.

29. A method according to claim 20 characterised in that the innermost and outermost seals are separate.

30. A seal assembly substantially as described with reference to the accompanying examples.



INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/GB 00/03547

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16J15/12 F16L41/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16J F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 1 549 562 A (CEA) 13 December 1968 (1968-12-13) page 2, left-hand column, line 48 - line 60; figure 2	1,2,5-8, 13,18, 19,25
X	GB 1 214 986 A (BAL) 9 December 1970 (1970-12-09) cited in the application page 1, line 55 -page 2, line 23; figure	1,2
A	US 5 040 828 A (KANE) 20 August 1991 (1991-08-20) column 2, line 47 - line 64; figures 2,3	1,21,22, 26

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
29 November 2000	06/12/2000

Name and mailing address of the ISA	Authorized officer
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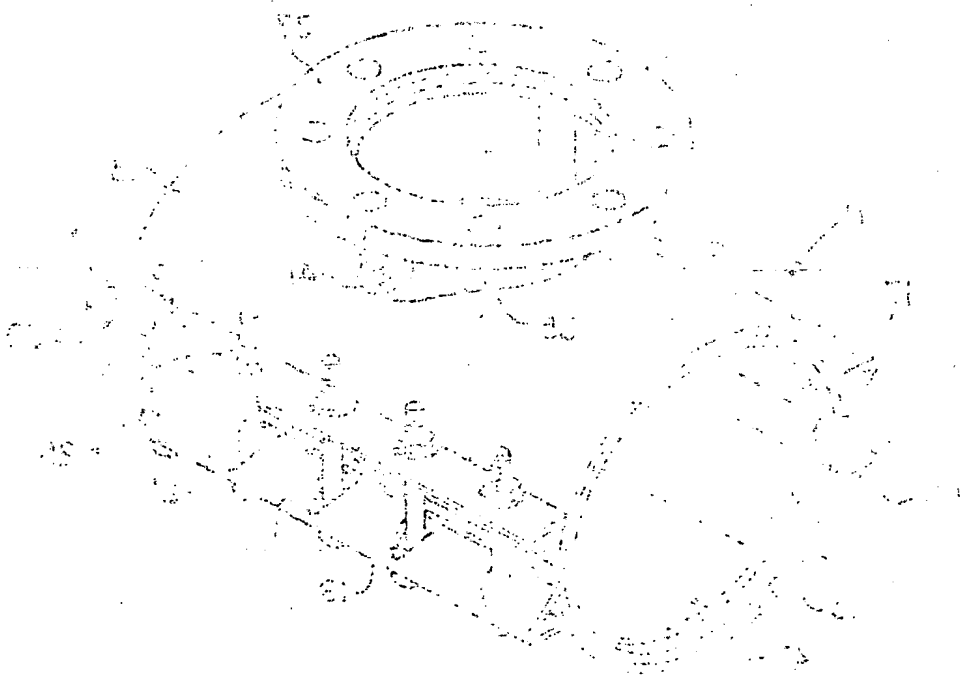
INTERNATIONAL SEARCH REPORT

...ormation on patent family members

Intern ...nal Application No
PCT/GB 00/03547

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 1549562 A	13-12-1968	NONE	
GB 1214986 A	09-12-1970	NONE	
US 5040828 A	20-08-1991	NONE	



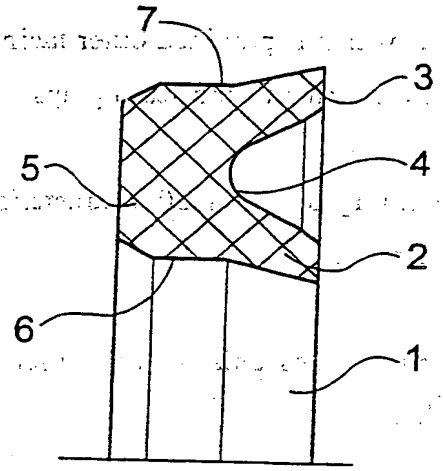


Fig. 1

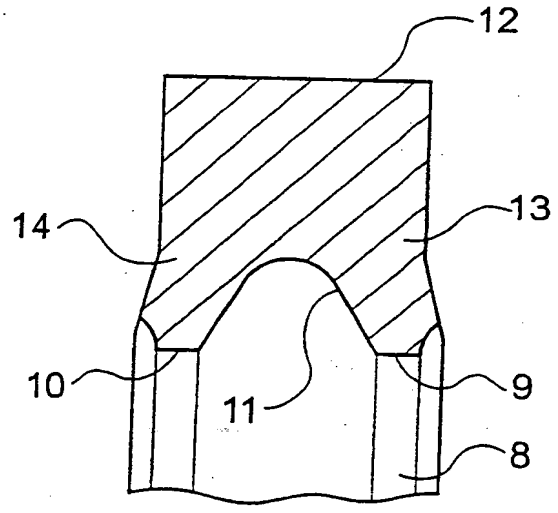
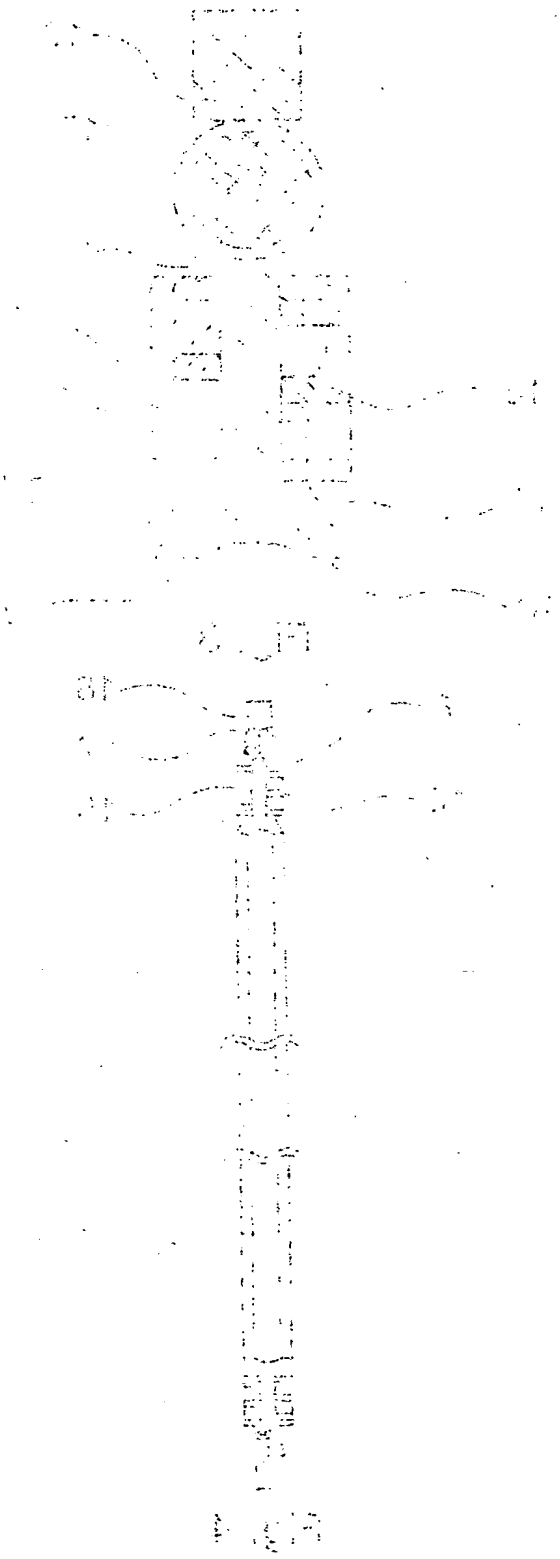


Fig. 2



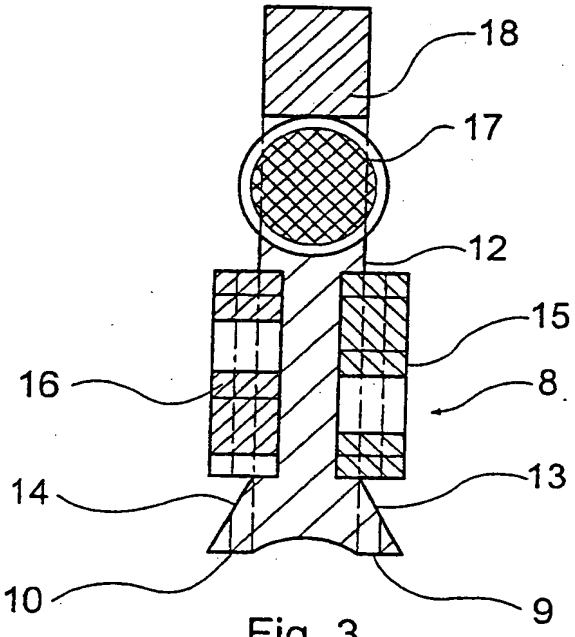


Fig. 3

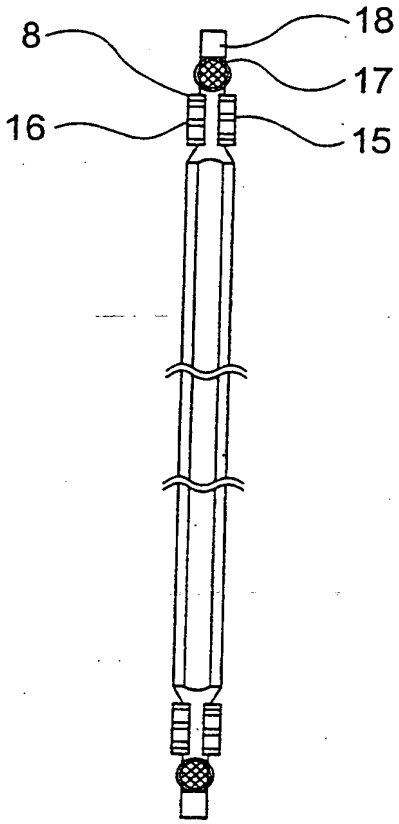


Fig. 4

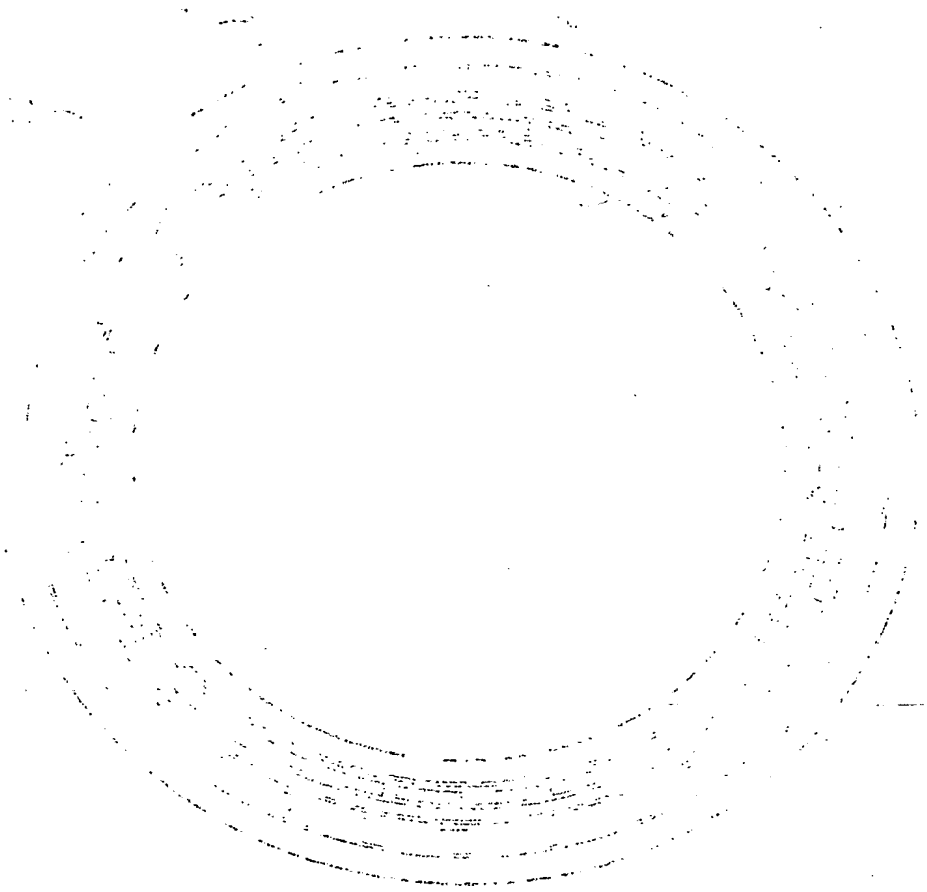


Fig. 8

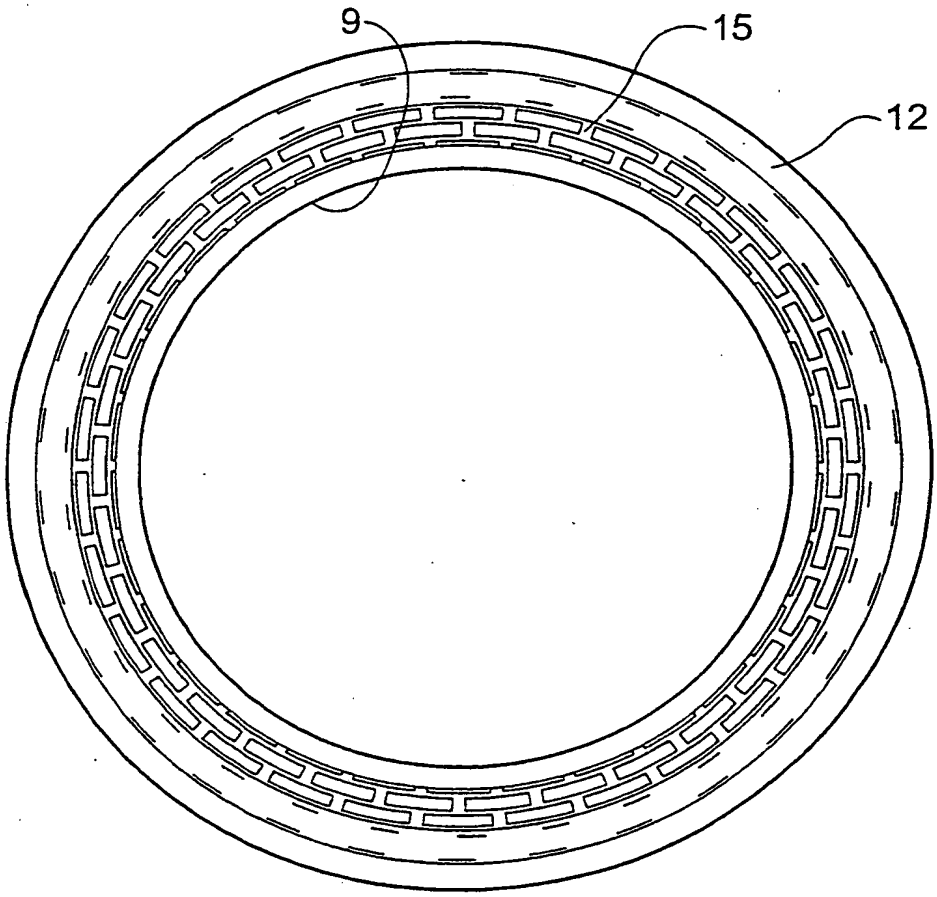


Fig. 5

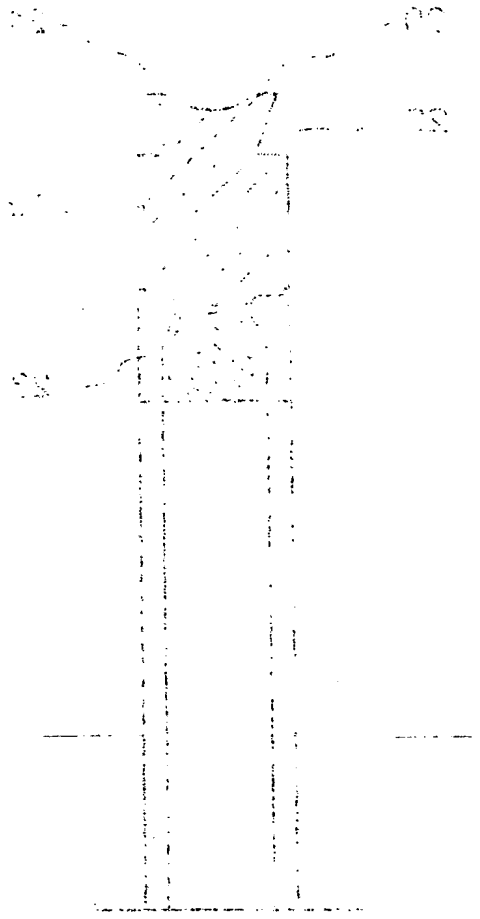


Fig. 3

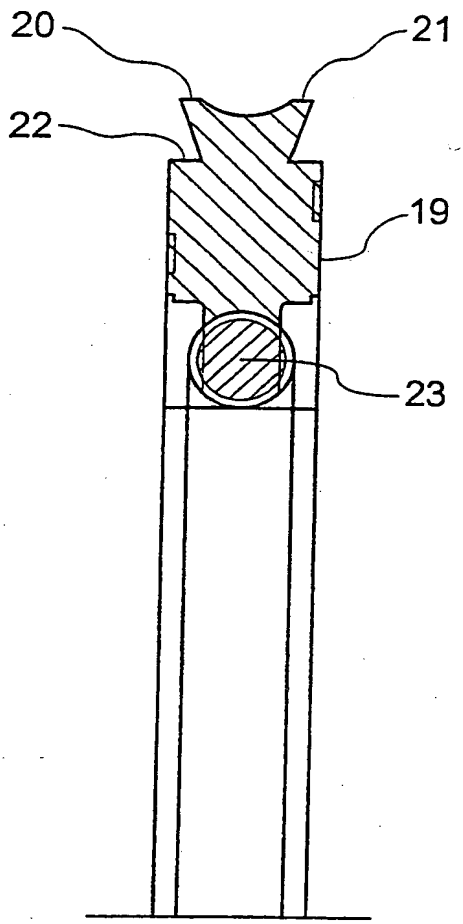
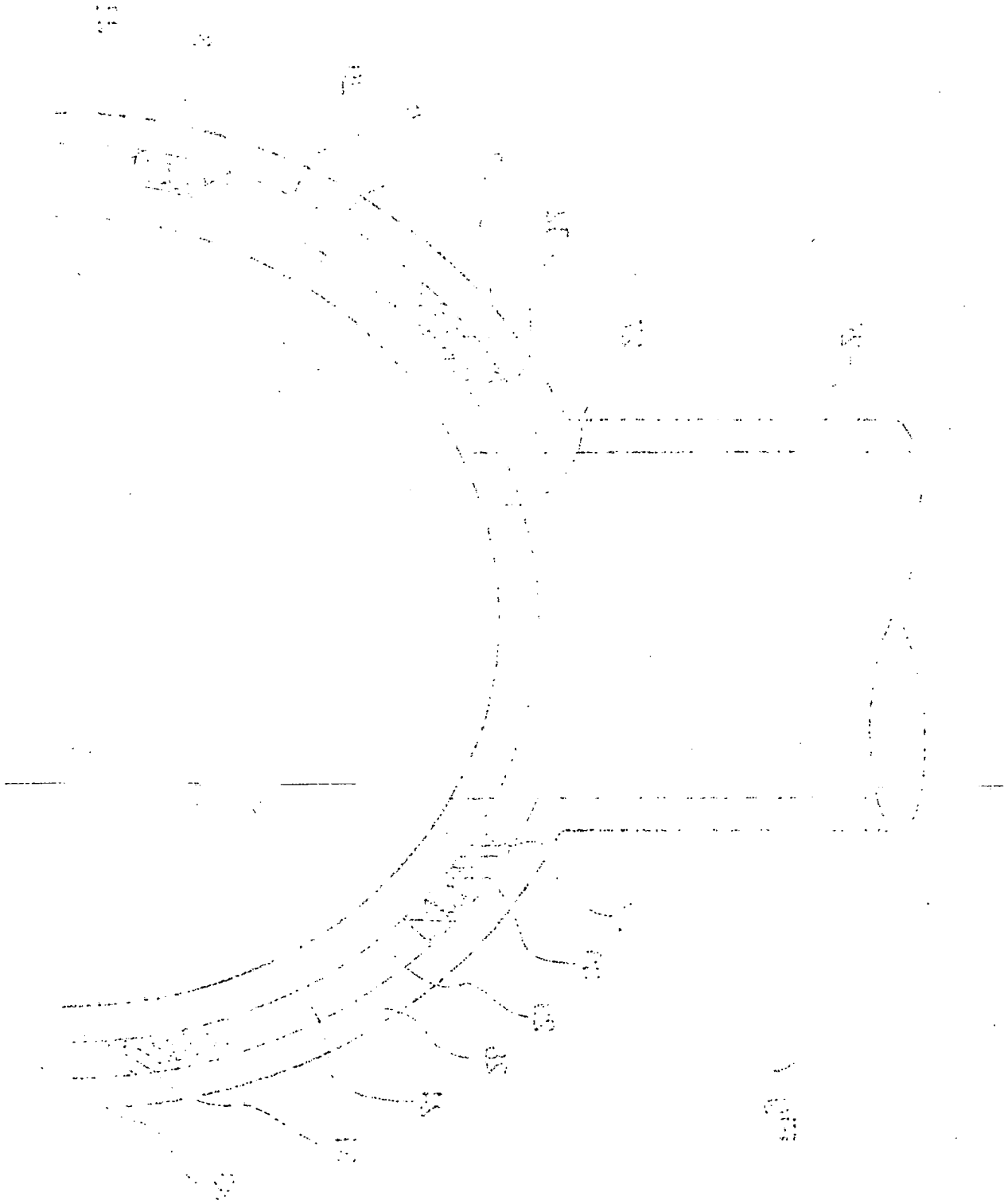


Fig. 6



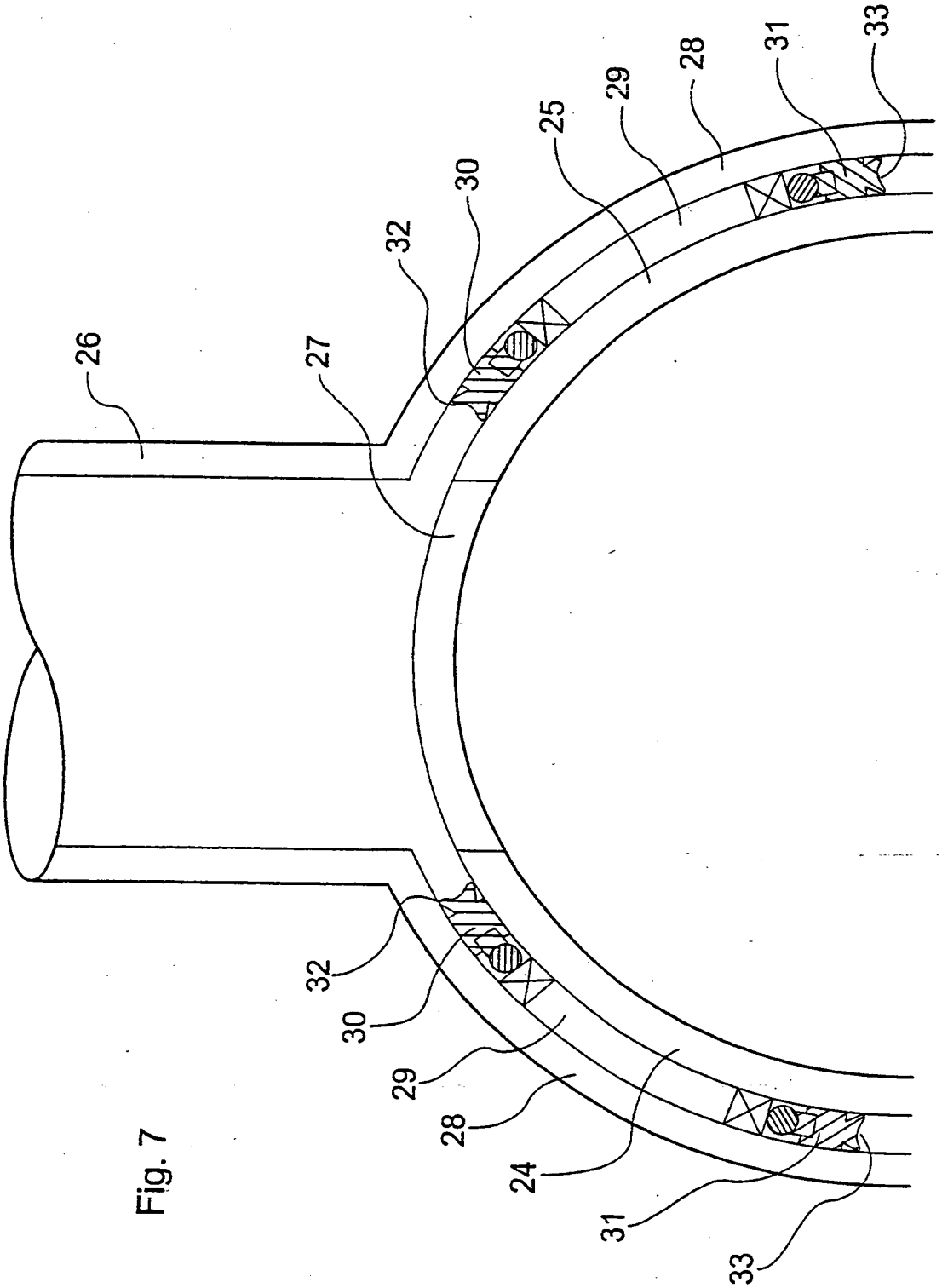
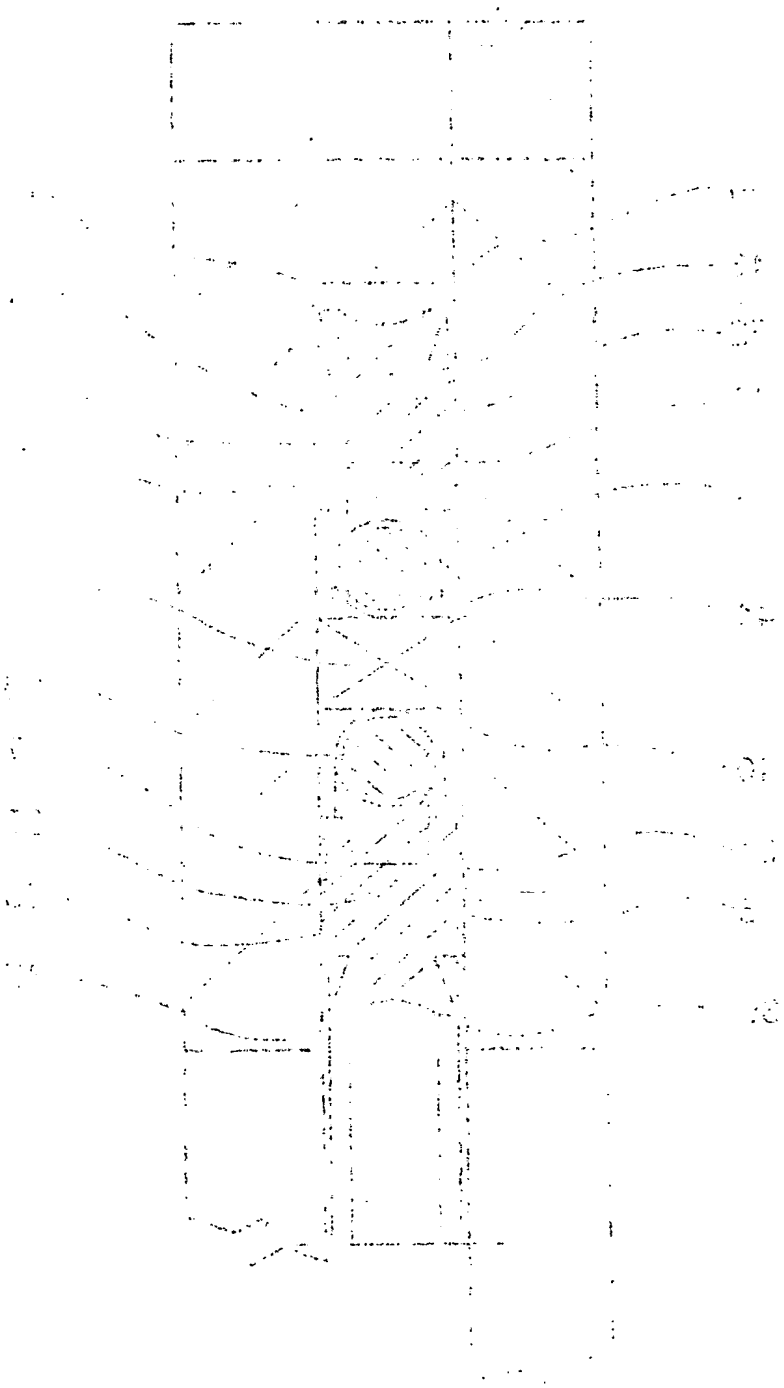


Fig. 7



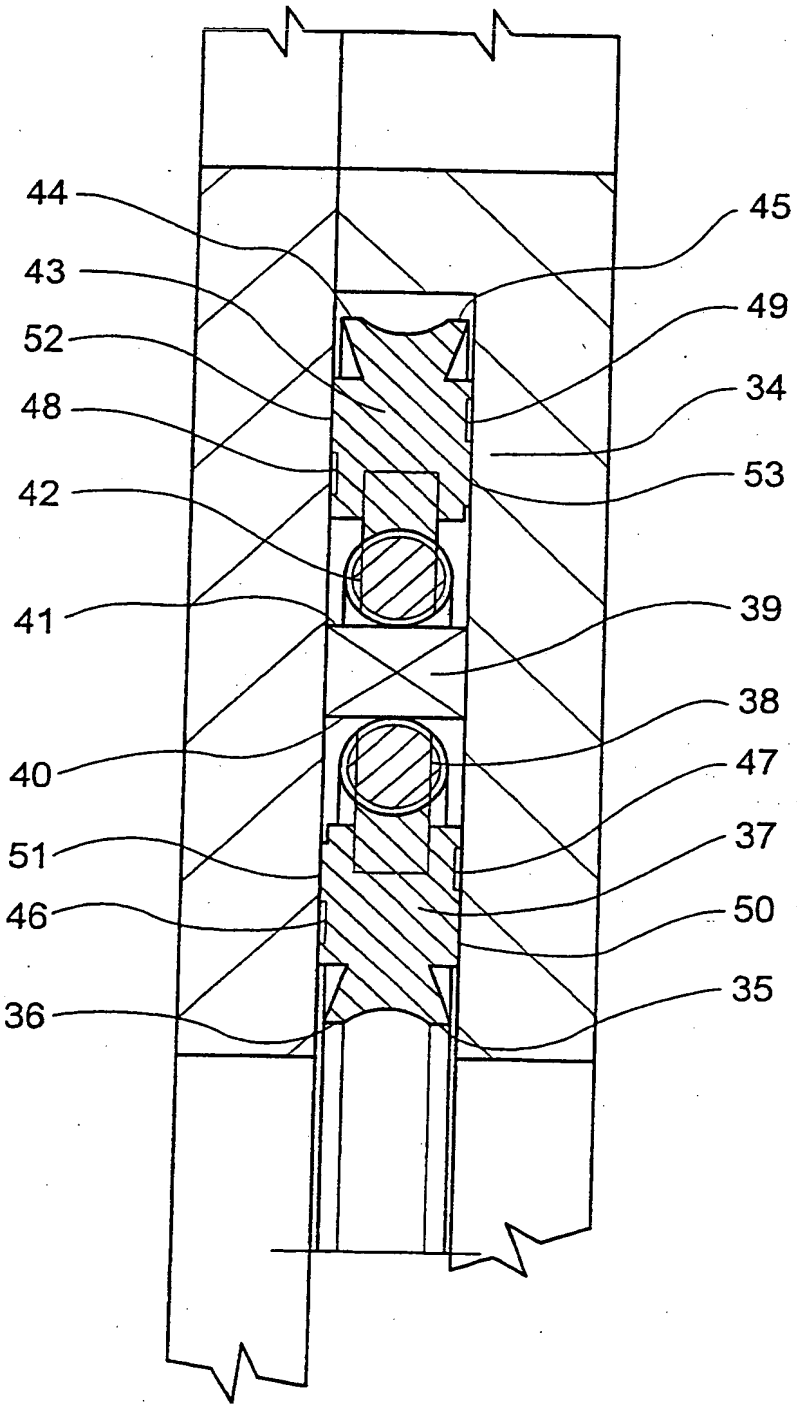


Fig. 8